

Is the $X(3915)$ the $\chi_{c0}(2P)$?

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The Particle Data Group has assigned the $X(3915)$ meson, an $\omega J/\psi$ mass peak seen in $B \rightarrow K\omega J/\psi$ decays and $\gamma\gamma \rightarrow \omega J/\psi$ two-photon fusion reactions, as the $\chi_{c0}(2P)$, the 2^3P_0 charmonium state. Here it is shown that if the $X(3915)$ is the $\chi_{c0}(2P)$, the measured strength of the $\gamma\gamma \rightarrow X(3915)$ signal implies an *upper* limit on the branching fraction $\mathcal{B}(\chi_{c0}(2P) \rightarrow \omega J/\psi) < 7.8\%$ that conflicts with a $> 14.3\%$ *lower* limit derived for the same quantity from the $B \rightarrow KX(3915)$ decay rate. Also, the absence any signal for $X(3915) \rightarrow D^0\bar{D}^0$ in $B^+ \rightarrow K^+D^0\bar{D}^0$ decays is used to establish the limit $\mathcal{B}(X(3915) \rightarrow D^0\bar{D}^0) < 1.2 \times \mathcal{B}(X(3915) \rightarrow \omega J/\psi)$. This contradicts expectations that $\chi_{c0}(2P)$ decays to $D^0\bar{D}^0$ would be a dominant process, while decays to $\omega J/\psi$, which are Okubo-Zweig-Iizuka suppressed, would be relatively rare. These, plus reasons given earlier by Guo and Meissner, raise serious doubts about the $X(3915) = \chi_{c0}(2P)$ assignment.

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INTRODUCTION

A number of meson candidates, dubbed the XYZ mesons, that contain charmed-quark anticharmed-quark ($c\bar{c}$) pairs but do not match expectations for any of the unassigned levels of the $c\bar{c}$ charmonium spectrum have been observed in recent experiments. Some have non-zero electric charge [1] and cannot be accommodated in the spectrum of charmonium mesons, which are all electrically neutral. Others are neutral and have quantum numbers that are accessible by $c\bar{c}$ systems, but have properties that fail to match the tightly constrained expectations of any of the unassigned charmonium states [2]. To date, there is no compelling theoretical explanation for these XYZ mesons. Experimental observations of additional states and more refined measurements of properties of the existing states may eventually reveal patterns that give clues to their underlying structure. An important part of this program is a careful distinction of new states that are conventional charmonium mesons from those that are not.

The $X(3915)$ was observed by Belle as a near-threshold peak in the $\omega J/\psi$ invariant mass distribution in exclusive $B \rightarrow K\omega J/\psi$ decays [3]; it was subsequently confirmed by BaBar [4]. An $\omega J/\psi$ mass peak with similar mass and width was reported by Belle in the two-photon fusion process $\gamma\gamma \rightarrow \omega J/\psi$ in 2010 [5]. BaBar reported confirmation of the $\gamma\gamma \rightarrow X(3915) \rightarrow \omega J/\psi$ observation [6] and, from a study of the angular correlations among the final-state particles, established the J^{PC} quantum numbers to be 0^{++} .

The similar masses and widths of the peaks seen in B decay and in two-photon fusion processes suggest that these are two different production mechanisms for the same state. The Particle Data Group's (PDG) average

values of the mass and width are [7]:

$$\begin{aligned} M(X(3915)) &= 3918.4 \pm 1.9 \text{ MeV} \\ \Gamma(X(3915)) &= 20.0 \pm 5.0 \text{ MeV}. \end{aligned} \quad (1)$$

The weighted average of the Belle [3] and BaBar [4] product branching fraction measurements for $X(3915)$ production in B decay is

$$\begin{aligned} \mathcal{B}(B^+ \rightarrow K^+ X(3915)) \times \mathcal{B}(X(3915) \rightarrow \omega J/\psi) \\ = 3.2 \pm 0.9 \times 10^{-5}, \end{aligned} \quad (2)$$

while the average of measured production rates in two-photon fusion (using $J^{PC} = 0^{++}$) gives [7]

$$\Gamma_{X(3915)}^{\gamma\gamma} \times \mathcal{B}(X(3915) \rightarrow \omega J/\psi) = 54 \pm 9 \text{ eV}, \quad (3)$$

where $\Gamma_{X(3915)}^{\gamma\gamma}$ is the partial width for $X(3915) \rightarrow \gamma\gamma$.

The presence of a J/ψ among its decay products indicate that the $X(3915)$ contains a $c\bar{c}$ quark pair. The only unassigned 0^{++} charmonium level in the vicinity of the $X(3915)$ mass is the $\chi_{c0}(2P)$, the first radial excitation of the χ_{c0} charmonium state. (In the following, the $\chi_{c0}(2P)$ referred to as the χ'_{c0} .) Because of this, the PDG identifies the $X(3915)$ as the χ'_{c0} . This assignment was disputed by Guo and Meissner [8], primarily because:

- the partial width for $X(3915) \rightarrow \omega J/\psi$ is too large for a decay process that is Okubo-Zweig-Iizuka (OZI) suppressed for a charmonium state;
- the lack of evidence for $X(3915) \rightarrow D\bar{D}$ decays, which are expected to be dominant χ'_{c0} decay modes;
- the small $\chi_{c2}(2P)$ - $\chi_{c0}(2P)$ mass splitting.

If the $X(3915)$ is not conventional charmonium but, instead, another XYZ meson, it would be the lightest

observed scalar and one of the narrowest of the new states. As such, it would likely play a key role in attempts to understand their underlying nature. Thus, the validity of the PDG assignment of the $X(3915)$ as the χ'_{c0} is a critical issue that needs to be carefully addressed. In this report I amplify some of the Guo-Meissner concerns and identify some other serious problems with the $X(3915) = \chi'_{c0}$ assignment.

THE $\chi_{c2}(2P)$ CHARMONIUM STATE

The properties of the χ'_{c0} are constrained by measurements of its $J = 2$ multiplet partner, the $\chi_{c2}(2P)$, or χ'_{c2} , that was seen by both Belle [9] and BaBar [10] as a distinct $M(D\bar{D})$ peak in the two-photon fusion process $\gamma\gamma \rightarrow D\bar{D}$. Both groups see a clear $\sin^4\theta^*$ production angle dependence that is characteristic of a $J = 2$ charmonium state, and there are no reasons to question the χ'_{c2} assignment. The Belle $M(D\bar{D})$ and $dN/d|\cos\theta^*|$ distributions are shown in Fig. 1. Belle and BaBar measurements for the mass and width are in good agreement; the PDG average values are [7]:

$$\begin{aligned} M(\chi'_{c2}) &= 3927.2 \pm 2.6 \text{ MeV} \\ \Gamma(\chi'_{c2}) &= 24.0 \pm 6.0 \text{ MeV.} \end{aligned} \quad (4)$$

Belle and BaBar measurements of its two-photon production rate are also in good agreement and are characterized by the product [7]

$$\Gamma_{\chi'_{c2}}^{\gamma\gamma} \times \mathcal{B}(\chi'_{c2} \rightarrow D\bar{D}) = 210 \pm 40 \text{ eV.} \quad (5)$$

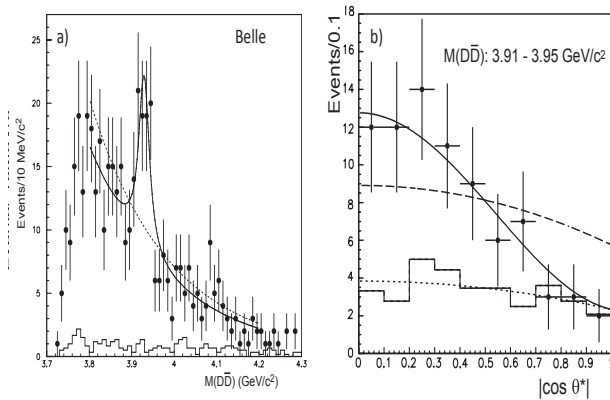


FIG. 1. **a)** The $M(D\bar{D})$ distributions for $\gamma\gamma \rightarrow D\bar{D}$ decays from ref. [9]. The open histogram shows the background level determined from D mass sidebands. The solid (dashed) curve shows the result of a fit that includes (excludes) a χ'_{c2} signal. **b)** The $dN/d|\cos\theta^*|$ distribution for events in the peak region. The solid (dashed) curve shows expectations for $J = 2$ ($J = 0$). The histogram shows the non-resonant contribution.

CONSEQUENCES OF $X(3915) = \chi'_{c0}$

The $\chi_{c2}(2P) - \chi_{c0}(2P)$ mass splitting

As pointed out by Guo and Meissner, the $X(3915) = \chi'_{c0}$ assignment implies an anomalously small $\chi_{c2}(2P) - \chi_{c0}(2P)$ mass splitting. Current measurements put it at $\Delta M(2P) = 8.8 \pm 3.2 \text{ MeV}$, in which case

$$r_c \equiv \frac{\Delta M(2P)}{\Delta M(1P)} = 0.06 \pm 0.02. \quad (6)$$

This is much smaller than the corresponding ratio for the bottomonium system, $r_b = 0.69 \pm 0.01$, and potential model predictions for charmonium that are in the range $0.6 < r_c < 0.9$ [11]. A study of modifications to potential-model mass calculations caused by couplings to open charmed mesons, finds that these effects reduce the expected splitting to $r_c \simeq 0.24$ [12], which is still large compared to the observed splitting (Eq. 6). Moreover, this study used a stronger χ'_{c0} - $D\bar{D}$ coupling strength then can be supported by measured $X(3915)$ data; the study's resultant $\chi'_{c0} \rightarrow D\bar{D}$ partial width was 12.4 MeV, which is nearly twice as large as an upper limit on this quantity that is derived below.

Limits on $\mathcal{B}(\chi'_{c0} \rightarrow \omega J/\psi)$

Using measured numbers and some conservative assumptions, I derive an upper limit on $\mathcal{B}(\chi'_{c0} \rightarrow \omega J/\psi)$ from the two-photon fusion production rate that is more than a factor of two below a lower limit on the same quantity determined from the rate for χ'_{c0} production in $B^+ \rightarrow K^+ \chi'_{c0}$ decays.

From $\gamma\gamma \rightarrow \chi'_{c0} \rightarrow \omega J/\psi$: From Eq. 3 it is clear that an *upper* limit on $\mathcal{B}(\chi'_{c0} \rightarrow \omega J/\psi)$ can be inferred from a lower limit on $\Gamma_{\chi'_{c0}}^{\gamma\gamma}$. Potential model relations for $\Gamma_{\chi_{c0}(nP)}^{\gamma\gamma}$ and $\Gamma_{\chi_{c2}(nP)}^{\gamma\gamma}$ with one-loop QCD corrections are [13]:

$$\begin{aligned} \Gamma_{\chi_{c0}(nP)}^{\gamma\gamma} &= \frac{27e_c^4\alpha^2}{\mu^4} \left| \frac{dR_n}{dr}(0) \right|^2 \left[1 + \frac{\alpha_s}{\pi} \left(\frac{\pi^2}{3} - \frac{28}{9} \right) \right] \\ \Gamma_{\chi_{c2}(nP)}^{\gamma\gamma} &= \frac{36e_c^4\alpha^2}{5\mu^4} \left| \frac{dR_n}{dr}(0) \right|^2 \left[1 - \frac{\alpha_s}{\pi} \frac{16}{3} \right], \end{aligned} \quad (7)$$

where $e_c = 2/3$ is the charmed quark charge, α is the fine structure constant, μ is the reduced charmed quark mass, $R_n(r)$ is the $\chi_{cJ}(nP)$ radial wave function and α_s is the QCD coupling strength. From Eq. 7 one can infer the relation

$$\frac{\Gamma_{\chi_{c0}}^{\gamma\gamma}}{\Gamma_{\chi'_{c2}}^{\gamma\gamma}} \simeq \frac{\Gamma_{\chi_{c0}}^{\gamma\gamma}}{\Gamma_{\chi'_{c2}}^{\gamma\gamma}} = 4.5 \pm 0.6, \quad (8)$$

which is valid in potential models to the level of changes in the QCD correction factors due to the running of α_s between the χ_{cJ} and χ'_{cJ} masses, which are a few percent.

Since $\mathcal{B}(\chi'_{c2} \rightarrow D\bar{D})$ is necessarily less than unity, Eq. 5 implies a lower bound on $\Gamma_{\chi'_{c2}}^{\gamma\gamma}$. This, together with Eqs. 8 and 3, translates into the (90% CL) upper limit¹

$$\mathcal{B}(\chi'_{c0} \rightarrow \omega J/\psi) < 7.8\%. \quad (9)$$

From $B^+ \rightarrow K^+ \chi'_{c0}$; $\chi'_{c0} \rightarrow \omega J/\psi$: A lower limit of $\mathcal{B}(\chi'_{c0} \rightarrow \omega J/\psi)$ can be deduced from Eq. 2 if an upper limit on $\mathcal{B}(B^+ \rightarrow K^+ \chi'_{c0})$ can be established. Here I assume that the $\mathcal{B}(B^+ \rightarrow K^+ \chi'_{c0})$ is less than or equal to $\mathcal{B}(B^+ \rightarrow K^+ \chi_{c0})$, where the latter branching fraction has been measured to be [7]

$$\mathcal{B}(B^+ \rightarrow K^+ \chi_{c0}) = 1.34^{+0.19}_{-0.16} \times 10^{-4}. \quad (10)$$

This assumption is reasonable for a few reasons, including: the available phase space for $B \rightarrow K \chi'_{c0}$ is significantly smaller than that for $B \rightarrow K \chi_{c0}$; the B -meson decay rate to P -wave charmonium mesons is expected to be proportional to the $|\frac{dR_n}{dr}(0)|^2$ [14], which decreases with increasing n . Moreover, measured B meson branching fractions to excited charmonium states, where they exist, are all smaller than those to the ground states.² With this assumption, Eq. 2 translates into a 90% CL *lower* limit of

$$\mathcal{B}(\chi'_{c0} \rightarrow \omega J/\psi) > 14.3\%, \quad (11)$$

which is nearly a factor of two higher than the *upper* limit given in Eq. 9.

Limits on $\mathcal{B}(\chi'_{c0} \rightarrow D\bar{D})$

A peculiar feature of the $X(3915)$ is the absence of any evidence for it in either $\gamma\gamma \rightarrow D\bar{D}$ or $B \rightarrow K D\bar{D}$ processes even though Belle and BaBar have each studied both channels. Here I discuss limits on $\mathcal{B}(\chi'_{c0} \rightarrow D\bar{D})$ from these processes.

From $\gamma\gamma \rightarrow X(3915) \rightarrow D\bar{D}$: The possibility that an $X(3915) \rightarrow D\bar{D}$ signal is lurking in the $M(D\bar{D})$ and $dN/d|\cos\theta^*|$ distributions for $\gamma\gamma \rightarrow D\bar{D}$ from Belle and BaBar was examined by Chen, He, Liu and Matsuki [15]. Based on fits to Belle's measurements, they claim a signal for $\gamma\gamma \rightarrow X(3915) \rightarrow D\bar{D}$ with marginal significance at a strength that is 69% of that for the χ'_{c2} . I use this result to conclude that $\Gamma_{X(3915)}^{\gamma\gamma} \times \mathcal{B}(X(3915) \rightarrow D\bar{D}) < \Gamma_{\chi'_{c2}}^{\gamma\gamma} \times \mathcal{B}(\chi'_{c2} \rightarrow D\bar{D})$. If $X(3915) = \chi'_{c0}$, this, together with the ratio given in Eq. 8, implies a 90% CL upper limit

$$\mathcal{B}(\chi'_{c0} \rightarrow D\bar{D}) < 0.25 \mathcal{B}(\chi'_{c2} \rightarrow D\bar{D}) < 25\%, \quad (12)$$

which is well below theoretical expectations of nearly 100% [11, 12]. This upper limit corresponds to an upper limit on the partial width for $\chi'_{c0} \rightarrow D\bar{D}$ of 7 MeV.

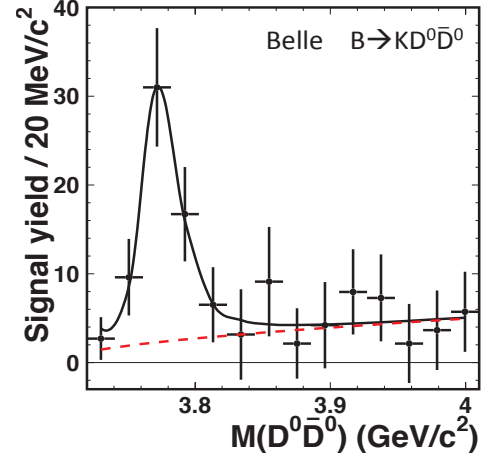


FIG. 2. The $M(D^0 \bar{D}^0)$ distribution for $B \rightarrow K D^0 \bar{D}^0$ decays from ref. [16]. The peak near 3.77 GeV is due to the $\psi(3770)$.

From $B^+ \rightarrow K^+ X(3915)$, $X(3915) \rightarrow D^0 \bar{D}^0$: The $D^0 \bar{D}^0$ invariant mass distribution for $B^+ \rightarrow K^+ D^0 \bar{D}^0$ decays from the Belle experiment [16] is shown in Fig. 2, where a strong, 68 ± 15 event signal for $B^+ \rightarrow K^+ \psi(3770)$; $\psi(3770) \rightarrow D^0 \bar{D}^0$ is evident. The measured product branching fraction for this process is [7]:

$$\begin{aligned} \mathcal{B}(B^+ \rightarrow K^+ \psi(3770)) \times \mathcal{B}(\psi(3770) \rightarrow D^0 \bar{D}^0) \\ = 1.6 \pm 0.6 \times 10^{-4}. \end{aligned} \quad (13)$$

There is no sign in Fig. 2 of a peak near $M(D^0 \bar{D}^0) \sim 3.92$ GeV that would correspond to the decay chain $B^+ \rightarrow K^+ X(3915)$, $X(3915) \rightarrow D^0 \bar{D}^0$. In fact, the Belle analysis attributes most of the events that are seen in the 3.92 GeV mass region to the process $B^+ \rightarrow D_{sJ}(2700)^+ \bar{D}^0$; $D_{sJ}(2700)^+ \rightarrow K^+ D^0$. Ignoring this possibility and attributing all of the 8 ± 5 events in the 20 MeV-wide bin centered at 3.917 GeV to the $X(3915)$, then scaling this to the $\psi(3770)$ signal (assuming constant acceptance) and comparing the result with the measured rate for $X(3915) \rightarrow \omega J/\psi$ production in B decays (Eq. 2) gives the 90% CL limit

$$\mathcal{B}(X(3915) \rightarrow D^0 \bar{D}^0) < 1.2 \times \mathcal{B}(X(3915) \rightarrow \omega J/\psi), \quad (14)$$

which is independent of the $X(3915) = \chi'_{c0}$ assumption or any properties of the charmonium model. For the $X(3915) = \chi'_{c0}$ scenario, this strongly conflicts with theoretical expectations that $\chi'_{c0} \rightarrow D^0 \bar{D}^0$ should be a dominant “fall-apart” mode with a branching fraction that is nearly 50% [12], while $\chi'_{c0} \rightarrow \omega J/\psi$ would be an OZI-suppressed decay mode. Measured OZI-suppressed charmonium decays have partial widths that are of order 100 keV or less. A partial width of this magnitude would

¹ In this paper I assume all errors are Gaussian and, when required, combine statistical and systematic errors in quadrature.

² For example [7], $\mathcal{B}(B^+ \rightarrow K^+ \psi')/\mathcal{B}(B^+ \rightarrow K^+ J/\psi) = 0.63 \pm 0.04$, $\mathcal{B}(B^+ \rightarrow K^+ \eta_c(2S))/\mathcal{B}(B^+ \rightarrow K^+ \eta_c) = 0.35 \pm 0.19$ and $\mathcal{B}(B^+ \rightarrow K^*(890)^+ \psi')/\mathcal{B}(B^+ \rightarrow K^*(890)^+ J/\psi) = 0.47 \pm 0.10$.

correspond to a $\chi'_{c0} \rightarrow \omega J/\psi$ branching fraction that is below 1%.

DISCUSSION

Any one of the points raised above would make the $X(3915) = \chi'_{c0}$ assignment unlikely; the combination of them all provides a *prima facie* case that it is incorrect or, at a minimum, premature. On the other hand, if the $X(3915)$ is not the χ'_{c0} , what is it? Also, where is the real χ'_{c0} ? In the following, I briefly discuss these issues.

Where is the χ'_{c0} ?

Gou and Meissner suggested that the “non-resonant” events seen by Belle and BaBar in the $\gamma\gamma \rightarrow D\bar{D}$ distribution (see Fig. 1a) are, in fact, due to $\chi'_{c0} \rightarrow D\bar{D}$. In their paper [8], they present fits to both the Belle and BaBar data that include a broad Breit Wigner (BW) function to represent the events under the χ'_{c2} peak. Their fits to both experiments’ distributions give an average mass and width for the broad BW of $M = 3837.6 \pm 11.5$ MeV and $\Gamma = 221 \pm 19$ MeV that they attribute to the χ'_{c0} . This mass, the strong $D\bar{D}$ signal, and the absence of any sign of a similarly broad signal in the $\gamma\gamma \rightarrow \omega J/\psi$ distributions from Belle [5] and BaBar [6], insure that this candidate for the χ'_{c0} does not suffer from any of the difficulties listed above. However, in their fit, Guo and Meissner ignore possible feeddown to the $D\bar{D}$ from $\chi'_{c0} \rightarrow D\bar{D}^*$; $\bar{D}^* \rightarrow D\pi(\gamma)$, where the π or γ is undetected. The $D\bar{D}$ events from this process would concentrate in a region that is about one pion mass below the χ'_{c0} peak and below the peak value from their fit. Since theoretical estimates of the $\chi'_{c0} \rightarrow D\bar{D}^*$ give a rate that is in the range of $0.3 \sim 0.5$ times that for $D\bar{D}$ [11, 12], this background would likely bias the Guo-Meissner fit to a lower mass value. With enough events, the strength of the $D\bar{D}^*$ contribution could be determined from the number of D^+D^0 events in the data sample and a combined study of neutral and charged $D\bar{D}^*$ pairs could remove such a bias [17]. This could be done at BelleII [18].

A Belle study of the annihilation processes $e^+e^- \rightarrow J/\psi(c\bar{c})$, where $(c\bar{c})$ represents charmonium states, found significant cross sections only for cases where $(c\bar{c})$ has zero spin [19]. This suggests that a signal for the χ'_{c0} might show up in $e^+e^- \rightarrow J/\psi D\bar{D}$ events. Figure 3 shows the $D\bar{D}$ invariant mass distribution for this process [20]. Here there is a clear excess of events above the non- J/ψ and/or non- $D\bar{D}$ backgrounds that are reliably determined from J/ψ and D mass sideband data and shown as a hatched histogram. Chao suggested that this event excess is due to the χ'_{c0} [21]. The Belle fit to this excess, shown in the figure as a solid

curve, returned a signal with a statistical significance of 3.8σ and a mass and width of $M = 3878 \pm 48$ MeV and $\Gamma = 347^{+316}_{-143}$ MeV, which are consistent with the Guo-Meissner fit values discussed above. However, since the Belle fit was unstable under variations of the background parameterization and of the bin width, they made no claims for an observation. A reanalysis of this channel with a larger data sample by the Belle group is currently in progress [22].

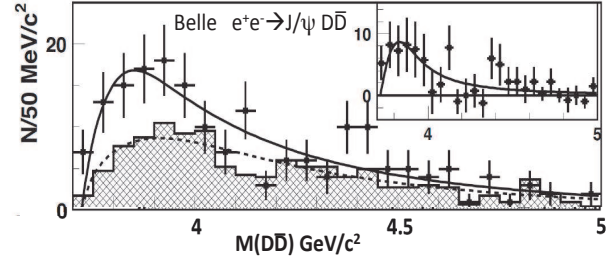


FIG. 3. The $M(D\bar{D})$ distribution for $e^+e^- \rightarrow J/\psi D\bar{D}$ decays from ref. [20]. The shaded histogram is the sum of non- J/ψ and non- $D\bar{D}$ backgrounds. The inset shows the background-subtracted distribution. The solid curve is the result of the fit discussed in the text.

What is the $X(3915)$?

A variety of structures for the XYZ mesons have been suggested, including: quark-antiquark-gluon hybrids [23]; tightly bound QCD tetraquarks in colored diquark-diantiquark configurations [24]; molecule-like structures formed from mesons bound by nuclear-like meson-exchange forces [25]; and hadrocharmonium in which $c\bar{c}$ states are bound to light-quarks and/or gluons via chromo-electric dipole forces [26]. In addition, some signals attributed to XYZ states have been interpreted as being due to cusps produced by coupled-channel near-threshold dynamics involving open-charmed mesons [27].

The $X(3915)$ mass is well below Lattice QCD calculated values for the lightest 0^{++} charmonium hybrid, which are around 4450 MeV [28]. It is also far from any relevant open-charmed-meson threshold. Thus, hybrid and cusp interpretations for the $X(3915)$ can probably be ruled out.

For a four-quark substructure, either of the QCD-tetraquark or meson-antimeson molecule variety, the decay $X(3915) \rightarrow \omega J/\psi$ would not be OZI-suppressed. In the QCD-tetraquark picture, the charmed and anticharmed quarks have correlated colors and are in close spatial proximity, conditions that could facilitate decays to hidden charmonium states. In a detailed study of one of the XYZ states (the $Z_c(3900)$) in the context of a QCD-tetraquark picture, partial widths for hadronic decays to hidden-charm states

are found to be much larger than those for decays to open-charmed mesons [29]. The hadrocharmonium model predicts similar results [30]. One could expect similar results from a corresponding analyses of the $X(3915)$.

If, instead, the $X(3915)$ has a $D^*\bar{D}^*$ molecule-like configuration, the charmed and anticharmed quarks would have less spatial overlap and their colors would be uncorrelated. In this case, one might expect that even though decays to final states with hidden charmonium are not OZI-suppressed, they might still not be very prominent. However, a specific model by Molina and Oset finds a 0^{++} (mostly) $D^*\bar{D}^*$ bound state with mass and width $M = 3943$ MeV and $\Gamma = 17$ MeV that couples strongly to $\omega J/\psi$ and weakly to $D\bar{D}$ [31], properties that match reasonably well to those of the $X(3915)$. This model predicts significant decays to $\phi\phi$ and $\omega\omega$ final states.

The $X(3915)$ could probably be accommodated by some versions of either a QCD-tetraquark model or a molecule-like picture. More experimental information about other decay channels, especially $D\bar{D}$, $\pi^+\pi^-\chi_{c0}$, $\omega\omega$ and $\phi\phi$, $\pi^+\pi^-$, and searches for other, possibly related states in the 3900 MeV mass region might help distinguish between the two possibilities.

SUMMARY

The mass, production rates and limits on the $\omega J/\psi$ and $D\bar{D}$ branching fractions of the $X(3915)$ make it a poor candidate for the χ'_{c0} charmonium state.

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